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ABSTRACT

This paper argues that the microcomputer has a place in early childhood education when it is coupled with microworld software. Microworld software formats are open-ended, user-designable, child-oriented software experiences providing children with direct access to specific concepts and the opportunity to exercise those concepts in meaningful ways. The use of microcomputers was approached from three major theoretical frameworks: those of Piaget/Papert, Erikson, and competence development. By presenting microcomputers in light of these theories, it was shown that many computer applications are developmentally appropriate for young children. Finally, using Bruner's idea that cognitive development is influenced by the culture's technological advancements, the paper concluded that caregivers' major commitment to children is to encourage the development of competence which can be fostered by using the microcomputer with microworld software. (BB)

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Will a Microcomputer Really Benefit Preschool Children?
A Theoretical Examination of Computer Applications in Early Childhood Education

Increased accessibility to microcomputers has given rise to a tremendous surge of interest in their potential influence in preschool education. The proliferation of personal computers, from college courses to nursery schools and into the home, prompted Kelman (1982) to identify this important issue; that no time has been taken to reflect upon the pedagogical, psychological, philosophical, and ethical issues". Since that time proponents have arisen on both sides of the issue. Whereas some (Barnes & Hill, 1983) have warned that young children should not be involved with microcomputers, others (Watson, Nida, & Shade, in press; Ziajka, 1983) have cautiously, albeit enthusiastically, argued otherwise. Barnes and Hill warned that the preschool child's preoperational thinking limits the benefits they can receive from microcomputers and requires their participation in other "real-life" activities. On the other hand, Ziajka pointed out that the microcomputer provides the opportunity for young children to engage in symbolic representation, a feat well within the preoperational child's repertoire (see semiotic function, Piaget, 1970). He further stated that, "someday we may want to add computer-generated images on a screen as a new form of representation that the child evokes and manipulates." Watson, Nida, and Shade (in press) have further concluded that the microcomputer should be viewed as

another educational "tool," no better or worse than books, crayons, paper, television, and . . . Lego blocks.

Who is right? Which path is the most appropriate for preschool children? When one considers such concerns it becomes imperative that attempts to understand the issues and/or integrate computers into early childhood curriculum be thoroughly grounded in a strong theoretical base. As Forman and Kushner (1983) have noted, theories of development, and their associated general principles, yield avenues into the young child's world. The purpose of this paper, then, is to present preschool computer interactions in the light of several theoretical frameworks.

Prominent Theories of Development

Piaget/Papert -- Objects to Think With

Piaget (1970) developed a model of children as builders of their own intellectual structures or knowledge. Without being taught children learn to speak, the intuitive geometry necessary to navigate through their world (Papert, 1980), as well as concepts like number and volume. Such "learning" involves the active exploration and consequent assimilation and accomodation of the child's environment. In other words, the child is an active participant in the acquisition or construction of knowledge. This model of learning can be enhanced by discovery oriented child-computer interactions. Such computer environments have been termed "microworlds." Papert (1980) defined a microworld as the following:

> A subset of reality or a construct of reality whose structure matches that of a given cognitive mechanism so as to provide an environment where the latter can operate effectively. The concept leads to the inventing of microworlds so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills (p. 204).

In other words, a microworld is an open-ended, user-designable, child-oriented, software experience where children have direct access to specific concepts and the ability to exercise those concepts in meaningful ways. Of course when Papert speaks of microworlds he is talking about Logo, the turtle, and turtle-geometry. Taylor (1980) described this as the "tutee" mode. Through programming, or "teaching" the turtle what to do, children come into contact with their own thinking as well as the geometry concepts hidden behind the easily recognizable attractiveness of the turtle.

A more expanded view of this software format relieves the child of programming and retains the interactive nature and child-in-control aspects essential to discovery based learning. This extended view of microworlds has recently been used with young children (Chaille & Littman, 1985; Lawler, 1982a; Lawler, 1982b; Shade & Watson, 1985). For example, Lawler designed a microworld called "beachworld" in which his three-year-old daughter could exercise (through simple keyboard functions) twenty computer graphics like sun, car, ball. The child typed in the word "sun" from a 4x6 card and instantly a graphic sun would appear in the clouds above the beach. At first the child did not know what the

words meant and only knew a few letters, however in three months she had learned to read the 20 words she had been exploring. Furthermore, when tested, by picking the same words off a printed page, she could read and relate their meaning.

The difference between this method of improving reading skills and the typical drill method are as follows. First, the child's motivation to participate in the learning experience came from her interest in an exciting activity. Second, the control this software format gave her enabled her to build a different beachworld everytime; much like blocks and sand. Third, the learning of letters and words was made incidental to discovering all about the beachworld. In other words, rather than drilling the child to death and teaching her that learning cannot be fun, this software capitalized on her natural tendencies to explore the world and discover important concepts along the way.

Shade and Watson (1985) recently used a microworld to teach three-year-old children to classify a unique array of objects (table, car, lamp, etc.) by the simple concept of inside/outside a house (a task many consider outside the preschooler's range of abilities). Children spent a total of one hour manipulating graphic objects in and around the background scene of a house and yard. Two groups of children, aged 18 to 42 months, were randomly assigned to groups by age and treatment. One group received the inside/outside microworld and the other group worked with software that drilled the alphabet. Although there were no

overall significant differences between groups, the age x treatment interaction approached significance at p=.053. In other words, the mean number of objects correctly classified by the three-year-olds in the microworld group was larger (8.27) than the alphabet three-year-old's mean (5.22). Post hoc power calculations revealed that a strong effect was present in the interaction and that significance was not reached because of the small sample size (n=10) in each group. This electronic houseplay enabled children as young as 36 months to construct the knowledge necessary to correctly classify a series of real objects when tested at the conclusion of the study.

In a similar light, Chaille and Littman (1985) have shown that computer simulations or microworlds can serve as "process highlighters" for young children. As such they can be used, in conjunction with related real-world object-based activities, to expose "hidden processes" or cause-and-effect relationships, thus increasing the efficiency of the young child's hypothesis testing. Chaille and Littman use the pendulum as an example of a hidden process that traditional early childhood materials do not access. Since the pendulum swings too rapidly for children to observe the trajectory they are limited in their ability to engage in the theory building or knowledge construction which they might in the context of using swinging objects to hit a target.

With computer activities such as these, virtually any concept, from the complexities of geometry to the simplicity of things that go inside or outside, can be modeled or

simulated. Second, when children work in these microworld situations, they are the ones in control; not the computer; and the more sophisticated the microworld the greater the control. For example, Lawler's (1982a) daughter was not only in control of what objects appeared in Beachworld, she also had control of when they appeared, how fast they went, and in what direction. Thirdly, microworlds are responsive to the child's previous experience and accumulated knowledge. Papert (1980) and Lawler (1982a) think this kind of learning is powerful because the child is able to bring together knowledge gained in diverse experiences. This serves to make the experience personally meaningful to the child, a feature that distinguishes learning from labor. Papert's classic example is of the child trying to draw a square or triangle with the Logo turtle. If a "bug" is experienced, the child can walk through the activity required of the turtle. Thus, knowledge of his/her own body and movement through space can be applied to the problem at hand. Finally, such software is great for preschool children because keyboard requirements can be minimized. Instant Logo, a single-key version, is already available for young children. Three-by-five cue cards can also be used, or the keyboard can be covered with stickers that highlight the few keys necessary for software manipulation.

Yet, in spite of these positive examples and features there are those who continue to criticize and lament. Recently several educators (Barnes & Hill, 1983; Cuffaro, 1984) have labeled microcomputer experiences of any type for

young children as "action in a vacuum, motion without context, and reality twice removed (Cuffaro, 1984). Most of these critics make the same assumption; that the preoperational child is incapable of benefiting from a computer learning experience due to cognitive limitations. This misconception has been dealt with elsewhere (Gelman & Baillargeon, 1983; Shade & Watson, 1985; Watson, Nida, & Shade, in press) but suffice it to say that indeed they can interact, understand, and use the information in a variety of ways.

Papert (1980), has his own way of dealing with this erroneous assumption. Although a student of Piaget, Papert differed in his interpretation of the prerequisites for cognitive development. Where Piaget talked about the complexity or formality of a concept, Papert stated that children simply need materials with which to work. Our culture, he continued, supplies some materials in abundance and some in relative poverty. For example, many things come in pairs (knives/forks, parents, shoes/socks). These natural pairs form the "materials" for learning an intuitive sense of number. Therefore developmental differences, according to Papert, might be attributed to materials "missing" from the child's milieu. Note the correspondence of this unique idea to Chaille and Littman's (1985) "hidden processes" example mentioned earlier. Papert referred to these "missing materials" as objects-to-think-with and has endeavored to fill the gap by providing robot-turtles and Logo

Although Logo has value alone as a means of teaching

children to think about thinking (Papert, 1980), turtle-geometry is only one concept in a world of many and each is worthy of investigation. It is the position of this author that the microcomputer, with microworld software, itself can be considered an "object-to-think-with." Space allows only a brief analysis of this position, however, based on the examples given earlier, it fulfills the standards set forth by Papert (1980) in "Mindstorms in the following ways: 1) computers are part of the natural landscape and culture (Who would not admit that they are simply everywhere, even in the preschool classroom?), 2) computers are part of the adult world and have the potential to become a transitional object between childhood and adulthood, 3) computers, when coupled with microworld software, are responsive to the previous learning the child brings to the experience, and 4) computers, with microworld software, can be used to think about formal systems such as language, classification, and tragectory.

Erikson -- Psychosocial Tasks

A second paradigm useful to preschool practitioners and researchers comes from Erikson's theory of Psychosocial development. Each of his stages (Salkind, 1979) are characterized by a developmental task or crisis that must be resolved for superior development to proceed. Three specific stages have special application to the child-computer paradigm: autonomy, initiative, and industry.

The microworld experience could be instrumental in helping a young child develop his/her autonomy. Antonomy

(Thomas, 1979) has been defined as a growing sense of power through control. Papert (1980) has noted that one of the most important by products of involvement with computers is the child's mastery of a sophisticated piece of space-age technology. It has been well documented (Borgh & Dickson, 1983; deRenzo, 1983; Muller, 1983; Pearlman, 1976; Shade & Watson, 1985; Shade, Nida, Daniel & Watson, 1984) that preschool children between 18 and 60 months can master a variety of computer tasks and various complexities in software. Furthermore, these children exhibit a great deal of pride when their actions lead to successful interactions with the computer. Children in such experiences have been observed to say (Shade et al., 1984), "I did it, I did it. I made it work" and a host of other positive exclamations. It is not hard to imagine that feelings resulting from successful computer experiences lead to an increased sense of power or autonomy.

With the successful development of autonomy comes a tide of initiative. From tolit training and other self-mastry tasks the preschool child has learned that s/he does have the ability to exercise control over some aspects of the environment. The logical desire is to discover all that the child can control. As the child continues to explore and master the physical and social environment initiative is increased (Fischer & Lazerson, 1984). Continued interaction with discovery-based microworld's like those previously described can help to encourage, maintain, and improve initiative.

Industry (Salkind, 1979) has been defined as the ability to master the social skills necessary to compete and function successfully in the society in which the child lives. This period constitutes the child's last opportunity to develop mastery over his/her environment. For a child living in an agricultural society the developmental tasks requisite for successful completion of this stage are associated with farming. Likewise, for today's child caught in the middle of a technological revolution, the requisite skills are computer related. Erikson (Salkind, 1979) has further noted the importance of surrounding social conditions in the successful achievement of industry. If society supports development in the form of good educational opportunities and adequate models in the home, the development of industry will be maximized.

Piaget/Papert, Erikson, and Others -- Competence Development in Young Children

Closely related to these theoretical foundations is competence development; which seems to be a logical extension of some of the best concepts from Piaget's and Erikson's theories. While definitions of competence vary to some degree, (Lange, Ladd, & Davis, 1982) there is increased consistency in what educational theorists and teachers believe to be important for enhanced early development and increased school achievement (Anderson & Messick, 1974; White, 1972). According to Lange et al. (1982) competency includes not only the specific numerical, spacial, and linguistic abilities necessary for symbol manipulation, but

just as importantly, an active, operative or instrumental disposition in examining and experimenting with objects in the environment. It is the competent child who spontaneously takes objects apart and then tries to fix them and transforms objects from one state to another to examine the effects of their own manipulations. More specifially they (White, 1972): 1) use adults as resources for getting information about how objects work and events proceed, 2) note discrepancies among objects and events, 3) plan and carry out multi-step activities, and 4) attempt to make interesting associations between the objects and events encountered in the environment. Furthermore, these children are self-motivated and self-regulated in the learning situation. They are active not passive (Baumrind, 1971) and are often labeled "bright" or "smart" by their teachers (White, 1972). These children fit the description of "little scientists" Piaget (1970) so often used to illustrate the nature of children's interactions with the world.

If we accept the assumption that it is good for children to develop such an active disposition, then we must accept the goal of helping them to do so. White (1979) identified a wealth of caregiver characteristics essential in the development of competence. Such caregivers, he noted, functioned as designers of their child's environment, functioned as a consultant for the child, disciplined consistently, and were not egocentric. More specifically they: 1) talked a great a deal to their children on the child's level, 2) made the child feel their activities were

interesting and worthwhile, 3) provided access to many objects and diverse situations, 4) demonstrated and explained things, 5) made interesting associations and suggestions, 6) strengthened the child's natural motivation to learn, 7) encouraged completion of tasks, and 8) gave enormous amounts of "on-the-fly" teaching.

How Can the Microcomputer and Microworlds Help?

There are several ways the microcomputer, with microworld software, can assist caregivers in fostering competence development in children. It is not being suggested that the computer replace caregivers; only that it is well equipped to supplement their efforts to design an effective environment. For example, the computer maximizes the child's actions by combining visual, auditory, and kinetic feedback simultaneously. Such intense, immediate feedback helps strengthen the child's natural motivation to learn. This is indeed the case as several researchers (Borgh & Dickson, 1983; Muller, 1983; Shade et al., 1984) found that preschool children seem "drawn" to the computer and show a preference for working with concepts at the computer rather than the traditional way they are presented. Furthermore, as noted earlier, competent children are aware that their actions have consequences. The microcomuter can further the development of this awareness. A young child learning to draw a square using a screen- or floor-turtle and Logo finds out early that each action is followed by an immediate consequence. The turtle may move in the desired

direction or a "bug" may appear that needs to be worked through. Such immediate results serve to bind together the child's actions and their effects.

Microworlds could be designed to maximize exploratory behavior. Children might be exposed to "hidden processes" and thus be better equipped to note discrepancies that exist among objects and events (Chaille & Littman, 1985) in their world. Microworlds could be used to help children draw interesting associations between objects and events. Children playing with a computer doll-house can discover simple associations such as the inside/outside concept presented earlier (Shade & Watson, 1985). Furthermore, through programming with simplified versions of Logo, children could be encouraged to plan and carry out multi-step activities. Research has yet to support this particular prediction (Sheingold, 1983) but other competencies have been documented. Clements (1985), for example, recently succeeded in showing that first graders who experienced 18 weeks of Logo training showed significant improvement in various aspects of creativity, originality, reflectivity, and metacognition when compared to a similar group who experienced CAI only.

Conclusions

An attempt has been made to show that the microcomputer, when coupled with microworld software, has a "fit" in early childhood education. This "fit" was approached from three major theoretical frameworks: Piaget/Papert, Erikson, and competence development. By

presenting microcomputers in light of these theories it was shown that many computer applications to young children are developmentally appropriate.

By way of conslusion, some thoughts from Jerome Bruner (1964) seem pertinent. Bruner stated that the intellect grows from the outside as well as the inside. In other words there are external, namely cultural, influences on cognitive development. Specifically Bruner spoke of the culture's technological advancements and how adult thinking and functioning are determined by this. As Lange et al. (1982) stated, a child may not choose to work with highly technical equipment but much of his/her adult life will still be affected by the presence of technology. Bruner stressed that the more complex a society becomes the less time there is to teach children (or allow them to discover) all they need to become competent adults. Since there is less time for teaching and discovery caregivers must tell children what world is like and rely on their child's ability to ask the right questions. As Lange et al. (1982) emphasized, if this line of reasoning is correct then our major commitment to children will be to encourage the development of competence - a child who is motivated and enjoys learning about the world around him/herself. If the microcomputer with microworld software can help foster competence development than it is time to accept it for the powerful tool it really is.

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